

What is Claimed is:

1. A method executed in a computer system for producing a combined system of partial differential equations comprising:

representing each of a plurality of systems as an application mode modeling physical

5 quantities of said each system;

determining a representation of a partial differential equation system for each application mode corresponding to one of said plurality of systems using at least one non-local coupling, said at least one non-local coupling defining a value from a first portion of a first domain to another part of a second domain; and

10 forming said combined system of partial differential equations using partial differential equation systems associated with said plurality of systems.

2. The method of Claim 1, wherein at least one of said partial differential equation systems uses at least one local coupling.

3. The method of Claim 1, wherein said first and second domain are the same.

4. The method of Claim 1, wherein said first and second domain are different.

20 5. The method of Claim 1, further comprising:

defining a non-local coupling wherein a value of a quantity on a boundary of said first domain are referenced in defining parallel lines extending into the domain.

6. The method of Claim 1, further comprising:

defining a non-local coupling in which a boundary condition associated with said first domain is defined using a value of an integral over a portion of one of: said first domain and said second domain.

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7. The method of Claim 1, further comprising:

defining a non-local coupling using at least one of: a mapped variable and an integrated variable.

8. The method of Claim 2, further comprising:

defining a local coupling using at least one of: a basic variable, an expression variable, and a glued variable.

9. The method of Claim 1, further comprising:

defining a non-local coupling variable using at least one of: an extrusion variable, a projection variable and a scalar variable.

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10. The method of Claim 1, further comprising:

determining a stiffness matrix by determining a Jacobian of each variable in accordance with each type of variable wherein said combined system of partial differential equations is in weak form, said stiffness matrix being a Jacobian matrix formed from a residual vector with respect to a number of degrees of freedom;

determining said residual vector by determining a Jacobian of each variable in accordance with each type of variable wherein said combined system of partial differential equations is in weak form.

11. The method of Claim 10, further comprising:

converting said combined system of partial differential equations from general form to weak form.

12. The method of Claim 11, wherein said determining said stiffness matrix further comprises:

determining values of a Jacobian of variables in accordance with points included in a quadrature formula and with other points in accordance coupling variables.

13. The method of Claim 12, wherein said determining said residual vector further comprises:

determining values of variables and a Jacobian of said variables for node points and for other points in accordance with coupling variables.

14. A computer program product for producing a combined system of partial differential equations comprising machine executable code for:

representing each of a plurality of systems as an application mode modeling physical

5 quantities of said each system;

determining a representation of a partial differential equation system for each application mode corresponding to one of said plurality of systems using at least one non-local coupling, said at least one non-local coupling defining a value from a first portion of a first domain to another part of a second domain; and

10 forming said combined system of partial differential equations using partial differential equation systems associated with said plurality of systems.

15 15. The computer program product of Claim 14, wherein at least one of said partial differential equation systems uses at least one local coupling.

16. The computer program product of Claim 14, wherein said first and second domain are the same.

20 17. The computer program product of Claim 14, wherein said first and second domain are different.

18. The computer program product of Claim 14, further comprising machine executable code for:

defining a non-local coupling wherein a value of a quantity on a boundary of said first domain are referenced in defining parallel lines extending into the domain.

19. The computer program product of Claim 14, further comprising machine executable
5 code for:

defining a non-local coupling in which a boundary condition associated with said first domain is defined using a value of an integral over a portion of one of: said first domain and said second domain.

10 20. The computer program product of Claim 14, further comprising machine executable code for:

defining a non-local coupling using at least one of: a mapped variable and an integrated variable.

15 21. The computer program product of Claim 15, further comprising machine executable code for:

defining a local coupling using at least one of: a basic variable, an expression variable, and a glued variable.

22. The computer program product of Claim 14, further comprising machine executable code for:

defining a non-local coupling variable using at least one of: an extrusion variable, a projection variable and a scalar variable.

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23. The computer program product of Claim 14, further comprising machine executable code for:

determining a stiffness matrix by determining a Jacobian of each variable in accordance with each type of variable wherein said combined system of partial differential equations is in weak form, said stiffness matrix being a Jacobian matrix formed from a residual vector with respect to a number of degrees of freedom;

determining said residual vector by determining a Jacobian of each variable in accordance with each type of variable wherein said combined system of partial differential equations is in weak form.

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24. The computer program product of Claim 23, further comprising machine executable code for:

converting said combined system of partial differential equations from general form to weak form.

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25. The computer program product of Claim 24, wherein said machine executable code for determining said stiffness matrix further comprises:

machine executable code for determining values of a Jacobian of variables in accordance with points included in a quadrature formula and with other points in accordance coupling
5 variables.

26. The computer program product of Claim 25, wherein said machine executable code for determining said residual vector further comprises machine executable code for:

determining values of variables and a Jacobian of said variables for node points and for
40 other points in accordance with coupling variables.